Standards Development Leading to Change in Design and Deconstruction Practices

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Abstract
Enhanced building sustainability can be achieved by increasing the quantity of materials, components and systems that may be recycled or reused at the end-of-life. Building design should explicitly consider all disassembly opportunities throughout the life-cycle. Improved demolition and deconstruction practices increase efficiency of natural resource use, reduce greenhouse gases, and decrease quantities of materials going to landfill. This paper describes the standards development environment and processes in Canada, as well as the existing Canadian standards addressing design for disassembly and adaptability (DfD/A) and effective deconstruction and disassembly. The initiation of new ISO standards development activities on DfD/A is also discussed.

Keywords:
building standards, deconstruction, design for disassembly and adaptability, sustainability

1 INTRODUCTION

In the quarter century since the publishing of the Bruntland Commission Report on Environmental Development [1], the core issues and requirements to meet the objectives of sustainable development (economic development; social equity and justice; and environmental protection) remain relatively unchanged.

Historically, the majority of the greening efforts associated with buildings and construction has centred on improving energy efficiency and reduced consumption. The promise that green buildings will have higher energy performance pleases building owners and operators on two distinct levels; an altruistic motivation to be environmentally friendly and the direct economic benefit of using less energy. Relatively little attention has been paid to the potential environmental and economic benefits of sound life-cycle management of construction materials.

Construction, renovation and demolition waste accounts for roughly a quarter of the solid waste disposal in Canada. In some regions of Canada there has been an increase in public awareness and concern over the shortage of available landfill disposal sites, subsequent excessive haulage distances for municipal waste, as well as greater consciousness of end-of-life resource utilisation issues. These concerns have resulted in several provincial and municipal jurisdictions implementing various controls on the responsibilities for end-of life material handling, on the makeup of the material sent to their landfills as well as controlling the tonnage being sent to landfill, in or out of their jurisdictions. In addition, there have been high level intergovernmental discussions to potentially broaden the application of Extended Producer Responsibility (EPR) to cover some conventional building products, most notably asphalt shingles [2].

Significant improvements in overall environmental stewardship and building sustainability could be made by increasing the quantity of materials, components, products and systems that may be recycled or reused at the end of a building's life-cycle. Such changes would lead to direct economic benefit to the recycling and reuse communities, produce longer lasting and adaptable facilities to the advantage of property developers, and ease the burden on landfill sites as well as reduce energy consumption.

To help make this a reality, the building design stage should explicitly consider disassembly requirements that may occur in normal life-cycle operations and maintenance activities as well as the more evident needs at the end-of-life. Similarly, enhanced and consistent demolition and deconstruction practices would improve the capacity of the building industry to contribute to the sustainable use of natural resources, reduce greenhouse gases, and decrease quantities of products and materials entering waste disposal sites.

The International Council for Research and Innovation in Building Construction (CIB) made an early identification of the potential contribution of deconstruction to sustainability objectives; significant in this regard was the initial work of CIB Task Group (TG) 16: Sustainable Construction. The collective works of CIB TG 39: Deconstruction, and subsequently CIB Commission W115: Construction Materials Stewardship [3,4,5,6,7,8,9,10], have provided immeasurable and invaluable guidance relative to deconstruction and material harvesting practices as well as development of various models for the Design for Deconstruction and the later distinguishing term Design for Disassembly (DfD). With time, the significance of adaptability to the life-cycle design and sustainable performance of buildings has become very evident; many of the efforts of CIB W115 now explicitly considering adaptability [9].

In 2004, in support of sustainable development initiatives of governments and the building industry, the CSA Group (CSA) established a Technical Committee (TC) on Sustainable Construction Practices (formerly the TC on Sustainable Buildings); tasked to develop national standards to advance the design, construction and maintenance of buildings in a sustainable manner.

The remainder of this paper describes the standards development environment in Canada, the standards development process at CSA and goes on to describe the development and content of standards on DfD/A of buildings and a new standard identifying the procedures for effective deconstruction and disassembly. The recent acceptance and pending initiation of new standards development activities, under the purview of the International Organisation for Standardisation (ISO) TC 59 (Buildings and civil engineering works) based upon the CSA DfD/A document, is also briefly discussed.

2 STANDARDS DEVELOPMENT IN CANADA

The Standards Council of Canada (SCC) coordinates Canada's National Standards System and ensures Canada's input on standards issues in international standards organizations. The SCC accredits Canadian standards development organizations (SDOs) and also approves Canadian standards as National Standards of Canada based on a specific set of requirements. CSA is one of four accredited SDOs in Canada. Many of the standards developed by CSA are explicitly referenced in the building codes within Canada and as such, fulfilment of their stipulations becomes legally binding. Other CSA documents carry similar legal status once cited within contractual documents.

2.1 CSA - Standards Development Process

CSA, established in 1919, is the oldest and largest accredited SDO in Canada. CSA is a national, independent, not-for-profit membership association, serving business, all three levels of government and consumers in Canada and globally, with over 3000 published standards and codes. CSA's employees, with the involvement of its 8500 committee members develops product, system, and competency standards, codes, and other information products that promote public health and safety, improve the quality of life, preserve the environment, and facilitate trade. CSA's solutions address 54 different program areas such as environment, construction, quality, business management, energy, health care, public safety, and communications. CSA's overriding purpose is to make standards work for people and business.

CSA standards are developed using an accredited consensus-based process, ensuring respect for and input from diverse stakeholder interests. Volunteer experts develop the technical content of standards, represent various interest groups, ensuring relevant and balanced stakeholder participation. CSA committees are created using a "balanced matrix" approach, which means that each committee is formed in a way so as to capitalize on the combined strength and expertise of volunteer committee members. Volunteers are dedicated people from many walks of life such as business and industry, science and academia, labour, government and consumer groups. The time and expertise of volunteer committee members results in valuable in-kind contributions to the development of standards. The committee considers the views of all participants and develops the details of the standard by a consensus process. Substantial agreement among committee members, rather than a simple majority of votes, is necessary.

In accordance with the stipulations of the National Standards System and the standards development process, CSA formally reviews all standards for reaffirmation, withdrawal, or development of a new edition, every five years.

2.2 CSA TC on Sustainable Construction Practices

Early planning relative to standardization efforts on Sustainable construction practices began in 2002 and 2003 with three exploratory meetings amongst the main industry stakeholders. The meetings, organized by two federal government departments, Natural Resources Canada and Public Works and Government Services Canada, as well as CSA, brought together participants from government, representatives from the construction and design industries, CSA, and academia.

The main focus of these meetings was to discuss environment and sustainability issues in the built environment in general and the needs of the building industry in terms of the design, construction and maintenance of buildings respecting sustainability requirements in particular.

In 2004, CSA established a new TC on Sustainable Buildings (later renamed TC on Sustainable Construction Practices) whose main responsibility was to develop technical standards for the design, construction and maintenance of buildings respecting sustainability. Members of the new TC included most of the participants from the initial exploratory meetings and new members in order to provide broader representation of the relevant industry sectors and to meet the CSA directives on the balanced of member interests. The membership and expertise of this committee has changed and continued to evolve over the past eight year, as new capabilities were required, participants or affiliations changed and new work items emerged. The TC is free to benefit from the contributions and expert opinion of nonCanadian members so long as the blend of interests and capacities of the voting membership complies with the CSA directive governing balanced participation.

3 CSA GUIDELINE FOR DFD/A IN BUILDINGS

The preliminary meetings, mentioned above, had identified the 'design for disassembly and adaptability' as an area of interest in which there had not been any significant standards development activities elsewhere and as such a potential source of impact for the TC. With the intention of the long-term evolution and development of a full blown standard on this subject, the TC decided to produce a document to provide guidance on the conceptual framework, concepts and principles for the design of buildings following disassembly and adaptability principles. Feedback from the industry through field applications of the Guideline as well as any emerging research findings would be used to promote the guideline to a standard in the future.

The Guideline was developed using the consensus-based approach described above, in Section 2.1. The first edition of 'Guideline for Design for Disassembly and Adaptability in Buildings, CSA-Z782-06' [11] was published under the auspices of CSA in November 2006.

The CSA Z782 details a framework for reducing building construction waste via consideration at the design phase, by applying DfD/A principles. The objective of this Guideline is to provide an overview of DfD/A principles and a method of defining the scope of integrating these principles into the design process to reduce the overall environmental burden associated with material assemblies. Its contents include DfD/A conceptual framework, DfD/A concept, specific principles and annexes. The Guideline also reviews quantifiable metrics for each DfD/A principle that, subject to further development, can be assembled into a matrix or checklist to guide users in the direction of disassembly criteria design.

The Guideline can be used by architects, engineers, planners, building owners and environmental professionals to increase their understanding of their options, and by other parties who are responsible for designing, constructing and demolishing buildings. The Guideline is not to be used as a design tool; rather, it can be used to aid the comparison of environmental performance of various design options within the context of DfD/A principles. The CSA Z782 outlines and discusses the following 14 DfD/A principles:

- versatility;
- convertibility;
- expandability;
- accessibility;
- documentation of disassembly information;
- durability;
- exposed and reversible connections;
- independence;
- inherent finishes;
- recyclability;
- refurbishability;
- remanufacturability;
- reusability; and
- simplicity.

For each principle, a general discussion is given along with examples of potential strategies and measurable metrics. Using 'versatility' as an example, the general discussion would start with 'versatile buildings and spaces lend themselves to alternative uses with minor system changes'. Examples of potential strategies include building areas for multiple purposes part of the design and construction, e.g. a gymnasium can double as a community theatre. Measurable metrics can include the percentage of floor space or building footprint that has multiple uses on a daily, weekly or monthly basis, without requiring changes to the main features of the space.

Using 'durability' as a second example, the general discussion defines durability as 'the ability to exist for a long time without negatively impacting building performance or service life' and that 'durability provides reduced environmental impact by minimizing the maintenance or replacement of a product'. Examples of potential strategies include the use of materials with a high durability rating that require less frequent maintenance, repair or replacement. Measurable metrics can include the cost of maintenance as a percentage of purchase price and the lifespan of a given product compared to alternative products that serve the same function at the same performance.

The Guideline also includes an Annex on the feasibility assessment of design for disassembly options. A table was given to illustrate examples of specific elements or components/assembles being assessed for each DfD/A principle. Examples are related to mechanical systems, such as ducting, diffusers, pipes, flexible tubing, and connectors. Examples on flex duct options are shown in Table 1.

The same process can be used for other elements at the structural, building envelope, services or fit-up level. The tabular format can be used to assess early outline specifications to ensure DfD/A issues are being addressed and to identify opportunities for improvement.

4 CSA STANDARD FOR DECONSTRUCTION OF BUILDINGS AND THEIR RELATED PARTS

The composition of the TC on Sustainable Construction Practices was slightly reworked and broadened to engage deconstruction experts and the consensus-based approach, as described in Section 2.1, was applied for the development of the standard. The first edition of 'Deconstruction of buildings and their related parts, CSA-Z783-12' [12] was published in March 2012.

The Standard specifies minimum requirements for processes and procedures related to the deconstruction of buildings and is intended to be used by contractors, consultants, designers, building owners, regulators, and material supply and value chain organizations involved in deconstruction of a building that is at the end of its service life or undergoing renovations or alterations.

The Z783 applies to existing buildings where deconstruction is to be considered as a means to reconfigure, remove, or partially remove an existing building. The document provides the minimum criteria for the planning and management of a deconstruction project, including:

- the establishment of scope of a deconstruction effort; and
- the planning and procurement;
  - contract development and identification of required skill sets and responsibilities;
  - deconstruction plan – material recovery targets, material separation plans, process descriptions, and schedule description and coordination.

The Standard acknowledges that it is possible that materials or components removed from any given building will need to be assessed before reuse in another application and further states that that process is outside the scope of this Standard. The Z783 recognises that various jurisdictions may have laws or regulations with regard to special precautions and handling of goods, substances, and materials (including waste), and provides examples of materials or components that an assessment might deem unacceptable for reuse, potentially requiring special handling for recycling include those not meeting government efficiency, safety, or performance requirements.

As well, this Standard recognises that health and safety requirements are addressed by other existing CSA Standards and does identify the need for health and safety provisions in specific clauses

Because numerous options are available for deconstructing, removing, and separating materials and components, the Standard has not set any requirements on methods to be used. For example, separating and palletizing materials can be a logical decision for one project, whereas shipment of commingled materials can be a better decision for another project. However, the Standard contains an informative Annex that identifies procedures for typical materials removal, separation, and protection scenarios.

As well the Standard provides basic information on the tools to be used for deconstruction efforts, accepts that care shall be taken to avoid contamination of materials, components, products, and systems, and stipulates that recovered materials shall be tracked and records maintained during deconstruction, with review of records by the building owner on a regular basis. The Standard provides an informative sample deconstruction planning form. Table 2 depicts the summary sheet for that form. Further, the Standard requires that the deconstruction contractor provide a final report confirming that the deconstruction work has been performed in accordance with the deconstruction plan.

Design for disassembly summary	Versatility	Convertibility	Expandability	Durability	Accessibility	Independence	Simplicity	Reusability/recyclability	Refurbishability/ remanufacturability	Exposed/reversible connections	Inherent finishes	Documentation of disassembly information
Flex duct												
Flexible ducts can be reused and rerouted and are simple and easy to install	X		X				X			X		
Pre-insulated option is available							X					
Specify quick clamp connections										X		

Table 1: Sample assessment of design for disassembly and accessibility options [11]

Division*	Base material or component	Recovery targets		Actual recovery		% Reuse†	% Recycle	% Energy	% Waste
		Quantity	Units (m3 , m, kg)	Quantity	Units (m3 , m, kg)				
4									
5									
6									
7									
8									
9									
10									
11									
24									
33									

*Based on the National Master Specifications MasterFormat™ numbering system (see Clause B.2).

†See Clause 4.3.4 regarding suitability of materials for reuse.

Reuse target (%)	
Reuse actual (%)	
Recycle target (%)	
Recycle actual (%)	
Energy recovery target (%)	
Energy recovery actual (%)	
Waste target (%)	
Waste actual (%)	

Table 2: Deconstruction planning form – Summary sheet [12].

5 NEXT STEPS FOR THE CSA STANDARDS

The TC on Sustainable Construction Practices plans further development and elaboration of the CSA-Z782, with the objective of elevating the document from a guideline to a national standard. The TC Communication strategy has been developed in order to promote the use and the acceptance of the Z782 by various facets of the industry. This strategy will be further modified to raise awareness of the development of the Z783.

The TC has an on-going plan to collect data on the application of DfD/A principles and corresponding environmental benefits from past, current and future field applications. New research on the development of the DfD/A principles into framework, indicators, a method for understanding potential performance and a procedure for evaluating/comparing relative environment performance of DfD/A design options for office fit-ups is being considered.

In September of 2011, a Canadian representative to the ISO Technical Advisory Group (TAG) 8 Buildings, proposed a new work item for the development of an ISO standard on DfD/A and recommended using the CSA Z782 as a seed document. ISO has embraced the idea of the new work item, accepted the offer to employ CSA Z782 and has placed the standards development project under the purview of ISO TC59 - Buildings and civil engineering works. The work item is tentatively assigned to Subcommittee (SC) 17-Sustainability in buildings and civil engineering works, dependent upon that SC's acceptance of the task at the General Meeting of TC59, to be held in Tokyo in October 2012.

ISO TC59's acceptance of the CSA Z782-6 as seed document directly implies a desire by ISO TC59 for Canadian involvement in the future development of ISO standards on DfD/A. Several members of the CSA TC on Sustainability of Building Construction are also active members of the Canadian Mirror Committee to ISO TC59/SC17 and it is expected that at least one of those members will participate in the new work item, and anticipated that one of those members will be requested to head the unit assigned the task.

6 SUMMARY

As public concern on environmental and sustainability issues has risen, so too has comprehension of the impact and interaction between the built and natural environments. There is a pressing requirement to promote sustainable development and, as a result of the increased awareness and concern, a great potential for successful public acceptance of the required corrective and adaptive measures. This will require a modification to the conventional perspectives of standards and codes.

Traditionally, building codes and standards for design and construction have dealt primarily with the fulfilment of health and safety needs. Environmental and sustainability objectives are usually not addressed in building codes. Even the relatively inarguable necessity for improved building energy performance is inextricably linked to occupant-related health aspects such as indoor air quality and thermal comfort. Given the continuing increase in public concern over our environment and natural resource issues, and the maturing of the sustainable building industry, it is conceivable that building codes will one day address and include environmental and sustainability objectives.

It is essential that guidelines and standards, providing direction on the design, construction and maintenance of sustainable buildings be developed in support of the sustainable building industry's immediate needs and the potential requirements of future building code development to include environmental and sustainability objectives. Deconstruction, and DfD/A Guidelines are two tools that will lead to improved sustainability of built assets and standardization of those procedures will further enhance the benefits.

The standards development environment employed by CSA provides a forum for common ground, consensus building and continual improvement essential to a sustainable Canadian built environment. Since the publication of the CSA Z782 Guideline for Design for Disassembly and Adaptability in Buildings in 2006, and with the recent release of the CSA Z783 Standard on Deconstruction of buildings and their related parts, the CSA, together with the industry has been actively working towards information dissemination and further public recognition and acceptance of the direct impact that modified building design and deconstruction practices can have upon sustainability.

The next standardization and distribution venue is to be ISO. The development of DfD/A standards on an international level will provide the opportunity for the establishment of documents describing flexible, yet widely applicable, procedures toward a sustainable built environment. Essential to this is input from international experts in design, construction and deconstruction, with experience in various regulatory frameworks and jurisdictions. The base intent of ISO, and international standardisation, is to have/retain/maintain an internationally level playing field for any given domain, and the key to taking that notion to fruition is the diversity and completeness of expert opinion. Experts wishing to participate in the ISO TC59 DFD/A initiative are strongly encourage to contact their national standards member body of ISO.

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